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TESTING THEORIES OF LEGISLATIVE VOTING: DIMENSIONS, IDEOLOGY AND STRUCTURE

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Abstract

While dimensional studies of legislative voting find a single ideological dimension (Schneider 1979, Poole and Rosenthal 1985b), regression estimates find constituency and party dominant (Kau and Rubin 1979, Peltzman 1984), and ideology secondary (Kalt and Zupan 1984). This paper rescales the dimensional findings to show their improved classification success over the null hypothesis that votes are not unidimensional. With the rescaling, most votes are not explained by one dimension, and several dimensions are important.

Nevertheless, fewer dimensions are found than constituents' preferences suggest. Thus a model is developed where transactions costs of building coalitions reduce the number of dimensions. When legislative parties build internal coalitions to pass and defeat bills, voting on randomly drawn bills has a single party–oriented dimension. And natural ideological dimensions are reinforced if parties write bills and logroll along natural lines of cohesion.

Testing Theories of Legislative Voting:

Dimensions, Ideology and Structure

[T]he most common and durable source of factions has been the...unequal distribution of property. Those who hold and those who are without property have ever formed distinct interests...A landed interest, a manufacturing interest, a mercantile interest, a moneyed interest, with many lesser interests, grow up of necessity...and divide them into different classes. The regulation of these various...interests forms the principal task of modern legislation, and involves the spirit of party and faction in the necessary and ordinary operations of the government. (Federalist #10)

1. Introduction

Recently, dimensional studies of aggregate roll–call voting have found a single left–right ideological dimension (Schneider 1979, 1987; Poole 1981; Poole and Rosenthal 1985a, 1985b).[1] However, regression estimates of roll–call votes have found that constituency and party dominate (Kau, Keenan and Rubin 1982, Peltzman 1984, 1985), although ideology is an important secondary factor in some studies (Kalt and Zupan 1984, forthcoming). These results are contradictory: either a single variable or dimension explains voting or it does not.

Both approaches create biases by the questions the ask of the roll–call data. Dimensional studies *describe outcomes*, while regression studies try to *explain* outcomes in terms of *underlying causes*, particularly constituency. Most regression analyses neglect structure, including party, rules, and vote–trading, and neither approach analyzes structure's effect on voting or outcomes.[2]

Section 2 develops the two approaches in a spatial frame work, and illustrates opposing results with an example. Sections 3 and 4 show how the assumptions of dimensional and regression analysis are biased toward opposed findings. Dimensional studies overstate unimensionality largely by using a success criterion that overstates both the overall success of the dimensional method and the fit of the first dimension relative to later dimensions. A null hypothesis is developed: it shows the classification success of unidimensionality when the data are *not* unidimensional. Adjusted success ratios then show the *improvement* in classification above this level; they are calculated for several dimensional studies. Regression studies that omit legislative structure (rules, committees and parties), overstate the importance of constituency and understate the importance of ideological coalitions.

Even the adjusted dimensional findings are inconsistent with the constituency model–the first dimension is far more powerful than it should be if it represents an issue. Thus a theory is needed to show how the issue dimensions are reduced to the dimensionality of roll–call votes. Sections 5 and 6 develop such a theory.

Section 5 shows that parties can minimize transactions costs of organizing bills and vote–trades by choosing the party division and set of bills that follows the distribution of legislators' preferences. Transactions costs are lowest when voting is limited to one bill, on the lowest–cost cleavage. Section 6 shows the benefits of multiple roll–call votes on varying issue cleavages. First, they show constituents that a legislator favors their specific views. Second, legislation is innovation. When many issues are tied in one roll–call vote, legislators' preferences on individual issues are unknown. Third, legislators can avoid coercion by leaders if their votes are needed on many roll–calls. A simple model shows the trade–off of benefits and costs of additional roll–calls. Section 7 concludes.

2. Spatial Assumptions and an Example

Dimensional analysis requires an abstract space, defined by theory. Regression analysis defines a space a priori, usually with many dimensions, while in dimensional analysis the data define the space.

Regression analysis of voting has followed the economic paradigm of demand and supply. The dimensions are variables determining quantity: the prices (or quantities) of all complements and substitutes, the price of the good, and income. As the demand for a good "can be expressed as a function of all prices and income" (Russell and Wilkinson 1979: 52), in principle there are as many dimensions as goods in the economy. Bads like pollution are also dimensions. And, as a good is different in each time period, a dimension may be needed for each good in each time period. Finally, choices depend upon expectations of the future, so a dimension may be included for each good in each potential state of the world.

Regression estimates of roll–call voting include the demands of constituents and pressure groups, implying many dimensions.[3] Unidimensionality seems to require that people desire just one good, which seems implausible.

The statistical rules for deciding which variables to include are quite inclusive:

> Are the variables reasonable on theoretical grounds? Is each variable statistically significant (even if it explains only a small share of the variance)? Does adding the variable increase statistical power (by an F test)?

The variable should be included if any question is answered "yes".

If measurable basic dimensions are not known a priori, techniques can organize data with many variables (say, test or survey questions or roll–call votes) into a small number of dimensions according to a statistical criterion. Thus the data and the organizing principle determine the dimensions. Such techniques include factor analysis, multidimensional scaling, and Coombs' and Poole and Rosenthal's unfolding.[4]

These methods severely limit the number of dimensions: (1) Dimensions are usually found by a step–wise method. One dimension is estimated and its explanatory power calculated. A second dimension is estimated to fit the remaining errors, and its improvement on the first variable is calculated. As with stepwise regression, earlier dimensions are assigned a disproportionate share of the explained variation when the dimensions are uncorrelated. Jointly explained variation is assigned to earlier dimensions. (2) The dimensions are usually required to be orthogonal, although actual dimensions are invariably correlated. This forces later dimensions away from their best fits to the data.

Dimensional analysis often finds dimensions that seem to represent political and economic interests, ideology and so on.[5] That is, the dimensions represent causal factors. They can be identified by their correlations with variables like ADA or PAC ratings (Poole and Daniels 1985).

A numerical example shows how the methods differ. The 7 observations are shown in Table 1 and Figure 1. They could be legislators' bliss points in a two dimensional space or yes (+1) and no (–1) votes and abstentions (0) on two bills. Consider them true values which the statistical methods try to describe.[6]

How can the points be fit to a single dimension? Regression could estimate one vote with another; with one independent variable, it is like dimensional analysis, except that it minimizes quadratic error. The single dimension that classifies best is X = Y with the cleavage Y = –X. It correctly categorizes 12 of the 14 votes, counting abstentions that are off the cleavage as half correct. However, the R^2 for X = Y is zero (SSR = 4, while SSR for Y = 0 is also 4). The regression with Y the dependent variable is Y = .5X, with an R^2 = .25 (SSR = 3). But it correctly categorizes only 10 of the 14 votes. (Closeness counts in regression, but not in classification).

There may be other independent variables, say A, B, and C, which describe the legislators' choices. The Y votes are perfectly estimated by the line Y = –A + B + C, implying three dimensions. However, regression can overstate the number of required dimensions: since X = –A + C, the regression Y = X + B gives a perfect fit. Finally, dimensional analysis fails to fit a second dimension properly if it is fitted to the residuals from the first dimension (the points off X = Y); two lines (X = –Y, X = 0) do equally well, but each leaves one point incorrectly classified.

Thus, regression finds a different fit than dimensional methods, and it can "find" too many dimensions. Dimensional methods, however, can seem more successful than they really are (as with the R^2 = 0!), and they distort additional dimensions.

3. Critique of Dimensional Findings

The finding of recent dimensional studies that one dimension explains Congressional roll–calls is puzzling. Do citizens and politicians care about only one great issue? Earlier work that found several dimensions in Congressional voting can put these results in perspective.

3.1 Multidimensional findings

The major multidimensional findings are by Clausen (1967, 1973).[7] Issue dimensions are identified a priori; their existence is confirmed by finding that votes are highly correlated within each dimension, but have low correlations across dimensions. However, no one has tested the relative statistical success of one and several dimensions with this method, by placing these dimensions in a higher–dimension space and calculating whether a unidimensional reduction of the space would have as good statistical properties as the a priori multiple dimensions. If the policy dimensions do capture underlying differences, a single dimension should fit poorly. If the correlations across dimensions are high, as Jerrold Schneider (1979, p. 134) found between economic issues and foreign affairs and William Schneider (1982, 1983, 1984) reported across economic and social issues and foreign affairs, one dimension might categorize votes nearly as well as several dimensions.

However, multiple dimensions can also have theoretical value, as Figure 2 (Sundquist 1973) shows. He uses two dimensions to show how new, cross–cutting cleavages occur in American politics. He starts with a one–dimensional cleavage, but then a second (cross–cutting) issue develops, causing voting on both dimensions. To show why a specific group of voters realigned, Sundquist needs a new issue dimension. But after the new cleavage becomes stable, voting is on one dimension.

Thus, after the New Deal, Southern Democrats faced cross–cutting cleavages, since they were allied with Northern Democrats on New Deal spending (Peltzman 1985), while the one–party system, civil rights and foreign policy divided them from the North–dimensions separate from economic ideology (Collie and Brady 1985). Explaining Southern roll–call votes should require both economic and other variables: even if a one–dimensional liberal–conservative scale fits most votes, it misses the underlying forces that caused it.

3.2 A null hypothesis for unidimensional unfolding

Unidimensional unfolding seems to classify votes very successfully (Poole 1984, Poole and Daniels 1985, Poole and Rosenthal 1985a, 1985b, Ladha 1984). But "success" depends upon the appropriate null hypothesis: it shows the "success" of the model using data contrary to the model's assumptions (Weisberg 1978). We now develop such null hypotheses and calculates their success in classifying votes.[8,9,10]

Figure 2 illustrates this approach with two equally important issue dimensions and voters distributed equally across all four quadrants; so voters' positions on the two issues are uncorrelated. Suppose that there are equal numbers of bills on each issue and voters choose the issue position closer to their own.

While these issues are uncorrelated, if "left" is defined as corner A and "right" is corner D, 75% of the votes are correctly classified by the B–C cleavage that divides voters into "left" and "right". So one dimension gives 75% "success" even though no one votes according to ideology (the A–D dimension).

Thus, a single dimension could correctly classify 75% of votes when there are actually two dimensions. Also, while adding a second dimension gives 100% success, the first dimension would be credited with 3/4 of the predictive power, and neither dimension is a true issue dimension.

A null hypothesis has "random" behavior with respect to the model's assumptions. It gives a baseline success level, the classification success of the dimensional model when the data do not fit the model. We can then know how much more successfully the dimensional model classifies the actual voting data. The natural null hypothesis for a single dimension is a perfectly symmetrical distribution of votes in two dimensions. It assumes *zero correlation* between legislators' positions on the issues. (As zero correlation is improbable, this assumption is biased *in favor* of the dimensional estimates: correlation gives higher success for the null hypothesis. Another possible null hypothesis is that all correlations are equally probable. Since correlation ranges between +1 and –1 and in voting models all correlations are counted as positive, the average correlation would be .5.)[11]

Figure 3 shows the null hypothesis with two issue dimensions, orthogonal preferences and sixteen legislators. Their "bliss" points, shown as small circles, are distributed evenly around a circle in the two–dimensional issue space. Legislators vote for the position closer to their bliss point.[12] Clearly, the correlation of legislators' positions on the two issues is zero. One bill is now introduced at each legislator's bliss point; each divides the legislators into two equal groups (as in a minimum winning coalition). Thus, each cleavage line passes through the center and the cleavages are distributed evenly around the circle, as shown in the figure. With these assumptions, there should be no evidence for a single left–right dimension.

Yet the prediction that bills divide "left" from "right" has 75% success. Arbitrarily, call the left half of the legislators in Figure 3 "leftists" and the right half "rightists."[13] (Any other division does just as well.) The bill dividing legislators on the vertical cleavage gives a 100% correct left–right classification: all of the "leftists" are on one side and all of the "rightists" are on the other. The bill on the next cleavage has 87.5% correct classification (14 of 16 legislators). The bills on the succeeding cleavages have 75%, 62.5%, 50%, and then 62.5%, 75%, and 87.5% success. Since the left–right direction is inferred from the data and maximizes correct classification, 50% is the lowest possible success ratio. Average classification success is 75%–not far below the unidimensional success rates of 81–87% in Poole et. al. (Tables 2 and 3).

If the legislators' views on the two issues are not orthogonal, but rather have the "average" correlation of 50%, a still higher success rate is obtained. Figure 4 shows eight legislators' bliss points (*) in a two–dimensional space. Only two bills need be considered, one left–right and one up–down. Correlated tastes need not change the success of the left–right cleavage, which is still 75% (100% on the left–right bill, 50% on the up–down bill). But the most successful single dimension is A–B, which gives a cleavage, Y = –X, that correctly classifies 87.5% of the votes.[14]

If legislators are randomly distributed but bills are not, the predictive success of one dimension will increase and its location depends on the choice of bills. So dimensional methods identify the distribution of bills as much as the distribution of preferences.[15] For a dimension to show only legislators' preferences, either roll–call votes must be distributed in proportion to the relative importance of issues, or all bills must be equally important. If many roll–call votes are on a minor issue, the dimension's direction is likely to change.

These points are illustrated in Figure 3. If only pure left–right bills are proposed, classification success is 100%. If half are pure left–right and half are distributed equally across all alternatives, success is the average of 100% and 75%, or 87.5%. Now, Poole and Rosenthal's (1985b) average success for all roll calls is 82.832% (Table 2). If these votes were either perfectly left–right or random in two dimensions, 31% would be on the left–right dimension and 69% random [$a100 + (1-a)75 = 82.832$]. However, mostly unidimensional votes may not be exactly on that dimension. In Figure 3 they could be equally distributed on the 100% left–right and the two 87.5% cleavages, so their average was 93.75% correct. (If legislators make mistakes in voting, the same result holds). Now, with the same 82.832% correct classification, 42% are on the left–right cleavage.

Thus, classification success shows the distribution of cleavages on bills, but *not* the underlying distribution of preferences. Schneider (1979, p. 97) emphasizes this point, that Congress has a "truncated agenda" that excludes bills that the (liberal) minority prefer. (Bills by *all* small minorities are probably excluded from Congress' agenda, creating a bias toward relatively "centrist" bills or those of the dominant coalition). Actual roll calls are therefore only a small, biased subset of those suggested by the underlying preferences, a result VanDoren (1986) shows in detail for energy bills.

An example can show the importance of a truncated sample. Suppose that in Figure 3 there is "agenda control" by an individual on the left–right axis, who vetoes bills relatively unrelated to the left–right cleavage (Shepsle 1979), leaving only relatively left–right bills. This veto extends to the half of the potential bills in Figure 3 that are most orthogonal to the left–right cleavage. Those remaining give 87.5% success.

The null hypothesis has so far used a two–dimensional issue space to evaluate a one–dimensional cleavage. However, the underlying issue space surely has more than two dimensions. (For example, Poole and Daniels (1985) fit two and three dimensions to roll calls without obtaining a perfect fit (Table 3).) In choosing a null hypothesis with more than two dimensions, two issues must be addressed:

1. What is the appropriate number of dimensions?
2. What is the appropriate weighting of the dimensions?

Howard Rosenthal has proposed (in conversation) that an appropriate null hypothesis is an infinite number of dimensions of equal importance, for which correct classification should be 50%.[16] However, a null hypothesis should be a close and serious alternative to the hypothesis being tested (usually 1, sometimes 2 or 3 dimensions). An infinite number of insignificant dimensions is not a serious alternative, while one or two or three more dimensions *is*. So we find correct classification by one dimension for fully orthogonal voters in 3, 4, 5, 6 and 7 dimensions. Figure 2 showed that 4 voters, arrayed in a square, are enough to solve for two dimensions. This principle is extended to the 3 dimensional cube and the 4, 5, 6 and 7 dimensional hypercubes: a voter is located at each vertex; a bill dividing the voters in half is proposed at each legislator's bliss point, and the classification success of an arbitrary left–right cleavage is found. (All cleavages do equally well). The calculations are described in Appendix A. (No general formula is evident, and the success ratio does not always fall with additional dimensions). The results are

# of dimensions	success ratio
2	.75
3	.625
4	.625
5	.6484375
6	.5947266
7	.5882031

The average of dimensions 2–4 is .667, which seems a reasonable "few dimension" null hypothesis.

Alternatively, a bill could be proposed on each dimension. The vertices range from left to right; we index them i = 1...n for an n–dimensional hypercube. One bill proposed for each dimension means one bill for each of the i–indexed vertices. There is one left–right, i=1, bill, one on the i=2 dimension, one bill two dimensions from the left–right bill on the i=3 dimension, and so on. They might be called the "far–left" bill, the "left" bill, the "moderate left" bill, the "centrist" bill, and so on.[17] Now the percent correctly classified are

# of dimensions	success ratio
2	.75
3	.75
4	.75
5	.75
6	.7232143
7	.71875

Here .75 seems a good null hypothesis for several dimensions.

If issues vary in importance, we need an index that shows the effective number of issues of equal importance. The index used is the standard "numbers equivalent" inverse of the Herfindahl index, from economics and antitrust (Jacquemin 1987, pp. 50–53). It is the sum of the squares of the individual shares, s_i:

$$H = \sum_{i=1}^{n} s_i^2 \quad with \quad \sum_{i=1}^{n} s_i = 1$$

For n equally important issues, 1/H = n. Thus 1/H reduces the actual issues to the number of equal–sized issues.

With issues ranked by size, a hypothetical distribution of issues has a constant ratio β between the size of the ith issue, s_i, and that of the i+1th issue. For example, each issue might be 50% larger than the next; β = 1.5. *So* $s_i = \beta s^i + 1, \beta > 1$. We can calculate β for some potential issues. Political issue dimensions could be related to consumption, to industries, or to occupations. Their size distributions might approximate the size distribution of political issues. The distribution of issues in Congress can also be examined for energy proposals and all House roll calls:

Issues	# of cases	β
Consumption	12	1.51
Manufacturing Industries	20	1.22
Industries	9	1.34
Occupations	16	1.28
Energy Issues	9	1.32
House Roll Calls	15	1.41

Sources: Personal consumption expenditures for 1985, Bureau of Economic Analysis, U.S. Commerce Department. Manufacturing (Major Industry Groups) for 1984, Annual Survey of Manufacturers, Bureau of the Census. Industries, 1985, from GNP by Industry, Bureau of Economic Analysis, Department of Commerce. Occupations, 1980, 1980 Census. Energy issues, from VanDoren 1986. House Roll Calls, 1985, CQ Index. For specific $\beta's$, we now calculate hypothetical "equivalent numbers" for some finite cases and an infinite series. For $\beta = 1.5$, and n issues, 1/H is

# of dimensions:	2	3	4	5	6	7
1/H	1.9	2.7	3.4	3.8	4.2	4.5

For the infinite series $i=1,...\infty$, $1/H = (\beta+1)/(\beta-1)$, giving

β	1.2	1.25	1.33	1.4	1.5	2.0
1/H	11	9	7	6	5	3

Thus, even with a large (or infinite) number of dimensions that are not equally important, the *effective* number of dimensions is quite small–in the range of 3 to 7.

Perfectly orthogonal data is unlikely; a more reasonable null hypothesis would be random draws from orthogonal data, which would have some correlation. If those correlations could be calculated, a higher and more precise null hypothesis correct classification would be available. Appendix B has some exploratory calculations.

A different null hypothesis problem exists in studies (including Poole and Daniels 1985), that correlate votes with dimensions or voting scales like ADA rating. Such studies must be careful to avoid spurious correlations. For example, in Figure 2, there are two bills, one left–right and one up–down, with equal numbers of legislators in each quadrant. Suppose that A is considered "left" and is opposed to D, so A–D is the single dimension. The correlation between A–D and the votes on the two individual bills is .7071, even though the two bills are orthogonal so the correlation between votes on the left–right and up–down issues is 0.[18] But correlating an average of all votes with individual votes or other averages, gives high correlations purely as an artifact. Thus Poole and Daniels' (1985) .81 correlation between ADA rating and the left–right dimension may not be so surprising.

3.3 Dimensional findings recalibrated

A natural way to evaluate dimensional findings is by their classification improvement over the null hypothesis. Such findings are often placed on a 0–1 scale. If the null hypothesis is 75% correctly classified, unidimensional unfolding should do better, measuring improvement as the percentage of the previously incorrectly classified votes that are now correctly classified. Thus, a reported 80% success rate explains 5 points of the 25 points above the 75% null success ratio, for an adjusted success rate of 20%. (Success below 75% would be evidence against the 75% null hypothesis). Recalculations with null hypotheses of 75% and 66.7% are presented in Table 2.

As unidimensional classification never has less than 66.7% success over a period of more than 60 years (Poole and Rosenthal 1985b, Tables 1–4) for a variety of methods and issue domains, the 66.7% null hypothesis is not rejected.[19] (It is striking that all but two success ratios are between 75% and 90%, which seems very unlikely for a variable with a range of 50%–100%).

For the 75% null hypothesis, the classification success of one dimension is substantial but not dominant; about a third of the votes above 75% are successfully classified. With Ladha's unidimensional model, based upon utility maximization with error, 23–27% are successfully classified. This is good performance for a single variable, given the many possible determinants of legislators' votes. But it leaves most of the votes to be explained by other factors or by random error.[20] With the 66.7% null hypothesis, a higher success level of around 50% is attained, but it is not so high that little remains unexplained, as the original numbers implied.[21,22]

Table 3 recalibrates Poole and Daniels' (1985) reported classification success ratios, and R^2 from regressions of dimensions on interest group ratings. They use the same votes that led to the interest group ratings to find the dimensions. As the interest groups choose votes based on the major cleavages in the Congress, Section 3.2 showed that a fair null hypothesis is the success of one dimension fitted to two orthogonal dimensions with a zero correlation between them. It has a correlation of .7071 with them, and so an $R^2 = .5$, the null hypothesis for regressions in Table 3.

For the classification results, the second dimension is moderately important: 4–11% of votes. Interestingly, the first dimension is less successful as high majority votes are eliminated and the legislator's votes might affect policy. The regressions show an important first dimension, a moderate increase in R^2 from the second dimension, and a small increase from the third dimension.[23] Table 3's results seem similar to those of Ladha and Poole–Rosenthal in Table 2; the regressions seem more favorable to unidimensionality.

Considering all of these findings, Poole and Rosenthal's (1985a) claim to have developed a superior technique for finding dimensions remains warranted: the dimension(s) have substantial explanatory power. However, the dimensions, particularly the first, are not as powerful as they imply.

3.4 One dimension as a first step

The unidimensional findings are reminiscent of statistical consumer demand studies. First Engel's law was found: as family income rises the share of income spent on food falls–a one–dimensional analysis. Later, other dimensions were found: socioeconomic class, size of family, urban/rural. And demand patterns vary across goods: Engel's law does not hold for steak.

For Engel curves to be straight lines, and so fit exactly, preferences must be homothetic–indifference curves must have the same shape for every level of income, which is unlikely (Deaton and Muellbauer 1980:145–158). Nevertheless, in the classic study of family budgets (Prais and Houthakker 1955) the pure linear form gives an average R^2 of .81 for the six major food categories (p. 95), while a regression analysis with additional variables gives an R^2 of only .858 (p. 141).

Roll–call analysis could have a similar history. A crucial first dimension has been identified, but other dimensions are also being identified. And dimensions should be explained with deeper underlying causes.

Marxist class–based analysis provides another analogy. There are only two classes in a conflict: "Which side are you on?"[24] Yet some groups are not naturally on either side. *Analysis* of class conflict requires that we explain how these groups choose sides, even if during the conflict only two sides can be seen. The legislative majority rule forces two sides on any vote; perhaps it also forces coherence in voting along dimensional alignments.

4. Too Many Dimensions? Regression Analysis

Econometric estimates of roll–call votes use constituency, ideology and structure variables to find the cause of those votes. Numerous dimensions are needed to "explain" roll–call votes.[25] As each variable is a dimension, in principle, there are many dimensions. However the data invariably has high multicollinearity, implying that some dimensions are not necessary. The ideology variable in the regression studies is much like the first dimension found in the dimensional studies–Poole and Daniels' (1985) first dimension correlates highly with the ADA liberalism rating.

The underlying causal model is that changes in the independent variables cause changes in legislators' votes so that the causal factors can be found by significant regression coeffic ients and proportion of variation explained. The goal is to identify a structural model of legislative decisionmaking, that allows us to identify political equilibrium and to calculate changes in that equilibrium due to changes in the underlying parameters: constituency, party, ideology, structure. So regression should distinguish among these alternatives, and determine how much a change in each variable affects the outcome. Unidimensionality's value as a structural variable depends on whether left–right ideology is an essential explanatory variable. If ideology is important and not collinear with constituency or structure variables, ideology is a major independent causal factor. If ideology is important but is also largely collinear with constituency and structure variables, then the data are basically unidimensional but the underlying causes could be either constituency or ideology. And "ideology" may be a legislator's personal beliefs or the result of coalition building (Schneider 1986, Sections 5–6; Kalt and Zupan forthcoming).

In Kalt and Zupan (1984, forthcoming), Ladha (1984), Peltzman (1984, 1985), Kau and Rubin (1979), ideology is important, but constituency variables are more important.[26] Thus, in Kalt and Zupan (1984), R^2 falls considerably when "liberal ideology" is omitted, but ideology is not collinear with their numerous constituency variables.[27] Yet Peltzman (1985) claims that "ideology" is really just an overall pattern of constituency preferences. Many political and economic data are highly correlated. A method that picks out those correlations could find "ideology," while the votes were based purely on constituency.

To estimate roll–call votes with constituency variables, it would seem crucial to use constituency variables appropriate to the specific issue. Thus, energy issue votes could be based largely on coal, oil and natural gas reserves, jobs and consumption; farm issue votes should be based on production of wheat, corn, tobacco, etc. (This was Clausen's rationale for defining different issue arenas). *Perhaps* oil reserves explain civil rights, tobacco, and the Chrysler bailout votes as well as do more precisely–aimed variables. If so, it suggests that voting on individual issues in Congress is a charade, that just one factor (party, vote–trading, ideology?) really matters, and votes are not determined by what constituents or political supporters (or PACs) desire. This seems an extreme view.

Yet regression studies since Jackson (1974) have neglected party leadership despite theoretical work showing how important legislative "structure" is to voting (e.g., Shepsle 1979, Shepsle and Weingast 1986). Vote–trading along natural coalition lines also changes the relation between votes and issues, as shown below.

Tests of constituency vs. ideology have not yet found if either dominates the other. Since previous studies have used tests inconsistent with rational choice, as Ladha (1984) proves, one route is to modify the econometric tests to include rational choices and repeat the tests. Still, it seems that both ideology and constituency should have independent explanatory power. It is hard to believe that ideology or any single factor could completely override the many varied influences of constituents and contributors.

Yet some process seems to reduce that variety, and with it the number of dimensions. To see this, compare the importance of the largest dimensions in the dimensional estimates with the variables developed to represent constituencies and interests:

Importance of Dimension

Dimension Number:	#1	#2	#3
Dimensional Estimates			
75% Null Hyp.	32.2	8.1	
67% Null Hyp.	49.0	6.1	
Regression Estimates	62.4	12.2	2.8
Constituency variables			
State Pop.	10.7	7.7	6.8
Energy	29.2	18.6	14.7
Occupations	16.9	11.8	11.0
GNP	20.1	16.4	16.1
Mfg	11.7	11.4	11.2
Consumption	19.3	15.5	13.5
House Roll Calls	19.6	15.5	13.3

It is clear that the dimensional estimates overstate the importance of the first dimension and understate the importance of the other dimensions, compared to our estimate of the underlying dimensions' importance. The next two sections present a theory of a "stuctural" process that does just that.

5. A Theory of Efficient Parties

This section develops a model of parties that pass bills efficiently when transactions costs are positive. There are two equal–sized parties[28] and a symmetrical distribution of legislator bliss points in a two–dimensional issue space. Parties choose bills.

Legislators are distributed evenly within a rectangle, as shown by the points in Figure 5. A bill proposes a location in the space, x^1, as the alternative to the status quo, x^0. Legislators choose the bill x^0 or x^1 closer to their bliss points. Following Riker (1962), parties propose bills that will pass by a minimum winning coalition,[29] so bills divide the space into two half–spaces by a straight line that passes through the rectangle's center.

Parties attempt to maximize their members' net benefits by passing the most desirable bundle of bills while minimizing transactions costs. Transactions costs include both a fixed cost for each bill and a variable cost that is related to the distance between each legislator's bliss point, x_i, and the party's position, x^1 (Koford 1987). If legislators' losses are linear in distance (Enelow and Hinich 1984), and transactions costs are proportional to losses, the variable transactions costs are linear in distance.

Party equilibrium is shown in Figure 5, for a rectangular space with 60 legislators located at the corners of the "city blocks". Transaction costs per legislator are a fixed amount F, plus the distance, D_i, between x_i and x^1 in city blocks.[30] For example, take F and transactions costs per city block as 1.

With alternatives at the median, transactions costs for a bill causing a cleavage on the long (left–right) axis are (for each party) $\sum_i F = 30 + \sum_i D_i = 120$, so party transactions costs, T, are 150. The division along the median on the short (up–down) axis has the *same* transactions costs. If two parties were to organize a bill for each dimension, total transaction costs would be 2T for each bill, or 4T. But a lower–cost outcome, one two–dimensional bill, with total costs of 2T, should result.[31]

Since an n–dimensional space can be divided into two equal halves by an n–1 dimensional cleavage, even with a large number of issues and dimensions, two parties can divide the n dimensions into two equal parts. If the legislators are distributed nearly symmetrically, they can be equally divided along all possible cleavages.[32]

Now, if the status quo is not at the generalized median, but at the center of one of the parties, the other party chooses the x^1 that allows a minimum winning coalition. Transactions costs on the long dimension are $\sum_i F = 30 + \sum_i D_i = 66$, so T = 96. In contrast, transactions costs on the short dimension are $\sum_i F = 30 + \sum_i D_i = 40$, so T = 70. Thus, *when the two parties have differing positions*, parties oriented on the long dimension have lower transactions costs.

To generalize this point, whenever parties take symmetrical positions away from the generalized median, the lowest transac tion cost parties are oriented along the longest dimension. Furthermore, if the status quo is at a diagonal from the longest dimension, the optimal cleavage is turned toward that dimension. Figure 6 shows this case. With x^0 the status quo, D1 is the natural party cleavage, but it has transactions costs of T = 84 for each party. A shift toward the vertical cleavage can reduce transactions costs. For example, moving to the D2 cleavage saves 4 units in transactions costs. The loss of each party's outlying member, who is replaced by a more central member, saves 1. And 3 units are saved by moving the party's position from the point symmetrical with x^0 to x*, a point 1/2 –ε lower, and so closer to the party's center. In such a vote, an alternative like x* should win, moving the party cleavage closer to the "natural" cleavage. Perhaps this has occurred gradually in the former "solid South," or recently in the Rust Belt as it changes from a wealthy part of the country to one desiring special assistance.

When legislators' intensities of preference vary asymmetrically, intense minorities form logrolling coalitions. Their transactions costs can be reduced by combining several issues in a single bill: more votes can then be cast sincerely, while with separate bills insincere votes must be carefully monitored for cheating, and constituents will be disappointed.

Thus, at long–run equilibrium, with parties maximizing their members' gains, there is a "most efficient" cleavage dividing the two parties. Each party is located where the issue(s) that most divide legislators also divide the parties. Also, only one vote (on a bundle of all issues) is needed.[33] But, while one vote on one cleavage minimizes transactions costs, American legislatures have many votes on multiple cleavages, for reasons that are examined next.[34]

6. Benefits of Multiple Roll–Call Votes

Section 5 showed that a single roll–call vote on a multi–dimensional bill dividing the legislators on the lowest trans actions cleavage minimizes transactions costs.[35] So only one vote should occur. Yet the facts refute that conclusion. What makes the number of bills greater than one?

6.1 Explanations for Multiple Roll–Calls

Three reasons can be provided. First, legislators want not just to pass good bills, but to show their constituents that they are doing so. To do this they must vote with their constituents on bills that specifically benefit them, not just for the party position. (Most constituents do not want "Reagan's robot"–type legislators).[36]

Second, the party leaders may use roll–call votes to discover the true distribution of preferences on bills. Roll–call votes on actual bills, as opposed to informal straw polls or party caucuses, may give superior evidence of the legis lators' true preferences. Leaders must trade off the value of superior information from additional roll–call votes with the increased transactions costs.

In general, the leadership wishes to find the optimum that minimizes overall losses. If legislators have linear or quadratic loss functions in D_i, the distance between the proposal and their bliss points, small movements from the optimum will cause small losses. But a small movement from a non–optimal point toward the optimum provides substantial gains. If individual roll–call votes have a small cost compared to the gains from moving toward the optimum, additional roll–call votes have value. If the party leaders know the legislators' bliss points in the n–dimensional issue space only with error, and the error is reduced by roll–call votes, then there will be some number and distribution across issues of votes that will maximize the improved choice of optimum net of transactions costs.[37]

Third, legislators want to maintain their independence of the party leadership. A large number of individual votes gives the legislators power to defeat the leaders without turning down their party's entire legislative platform. Each individual legislator's power relative to the leadership is increased by additional roll–call votes. For with parties forming minimum winning coalitions, each voter is crucial to success. If legislators defect, either the party's bill will be defeated or higher–cost votes must be obtained. Either cost imposes a finite (tit for tat?) penalty upon the leaders.

The legislator's choice of independence is a short–term long–term tradeoff. A legislator can more easily vote against the leadership and current self–interest on one bill out of many to show independence. That might lead to popularity with other members and to a leadership position later. But such independence is difficult if all roll–calls are important to the legislator. Thus the legislature makes a "constitutional" tradeoff in making its rules: permitting more roll–call votes increases transactions costs but reduces the leaders' power. A similar tradeoff determines whether bills are chosen by party leaders or independently (by committees or floor amendments). Transactions costs are minimized by central control over bills, but legislators' independence is reduced.

6.2 Optimal Number and Distribution of Bills: Examples

This section shows examples of the tradeoff between the choice of the optimal set of bills and the transaction costs of additional roll–call votes.[38]

Roll–call votes can be used to identify the median voter on one dimension. If voters are distributed symmetrically on one dimension over a closed interval, two votes are sufficient to determine the median. A third vote will pass the median bill. Thus, 3 votes per dimension will determine the median. If the cost of a vote is 1 unit, each dimension's votes cost 3 units.

Now, there could be an infinite number of potential dimensions; they might be distributed like the issues of Section 5, with a constant ratio β between the ith largest issue and the i+1th. They may also be correlated with each other. For example, suppose that $\beta = 1.25$ and the most important issue has a value of 30. Then only 11 bills will have benefits greater than transactions costs, although they have 91% of the total potential value.

Combining in a single bill several highly correlated issues can provide greater net benefit than a bill on each issue. Suppose, for instance, that voting is on one issue dimension, but other issues are correlated with it. Then for two issues of value, u_i, i=1,2, and a correlation between the issues of α, the net gain from combining two bills is

$$-(1-\alpha)u_i + 3,$$

with a saving of 3 on transactions costs but a loss from imperfect knowledge of preferences on one bill. If $(1-\alpha)u_i < 3$ for i=1 or 2, there is a net gain from combining the issues in one bill. Voting should be on the more important issue to minimize the losses from imperfect correlations.

Optimal strategy with two correlated issues in a single bill requires voting on a dimension down the line of correlation. The loss–minimizing line should be the regression line through the positions on the correlated issues—an analysis that can be extended to additional issues.

Finally, several small bills can overcome the transactions costs hurdle if they are correlated. Suppose three bills worth 2 each, voting on one dimension, and $\alpha = .5$. Then $\sum_i u_i = 4$, greater than the transactions costs of 3.

In principle, knowledge of the underlying issues and their correlations allows the calculation of the optimal distribution of issues across bills and the combination of the smaller issues into the larger bills. The higher the average correlation among issues, the greater the gains from combining issues.

7. Conclusion

This paper critiques dimensional and regression analyses of legislative voting. Each's success has been overstated. Yet the unidimensional model's success beyond the effects of constituencies and issues must be explained. A theory of legislative parties with positive transactions costs explains how the number of bills is reduced from that of the underlying issue space, and tends toward the single most prominent dimension in that space.

Table 1

Dimensions and Regression

Case	X	Y	A	B	C
1	-1	-1	1	0	0
2	-1	0	1	1	0
3	0	-1	0	-1	0
4	0	0	0	0	0
5	0	1	0	1	0
6	1	0	0	-1	1
7	1	1	0	0	1

$(X = -A + C; \quad Y = -A + B + C)$

Figure 1

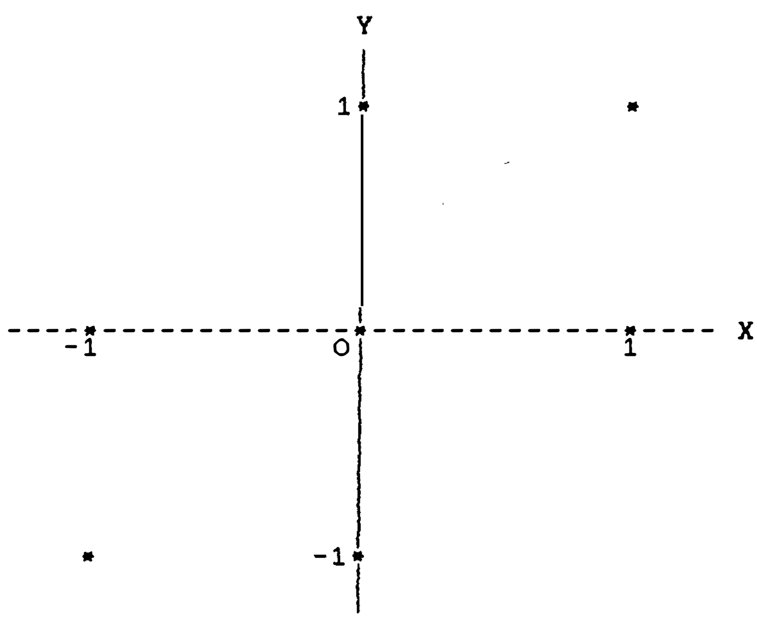
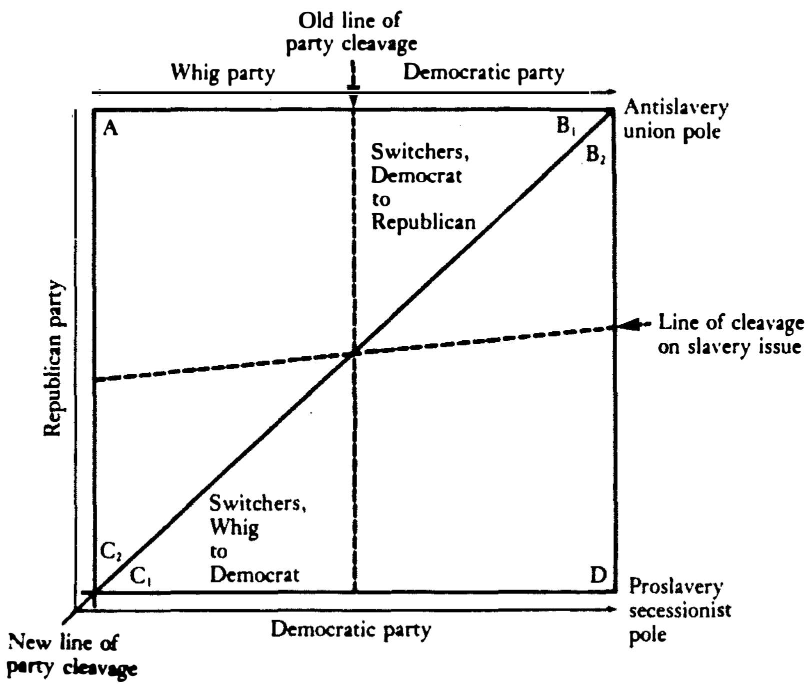


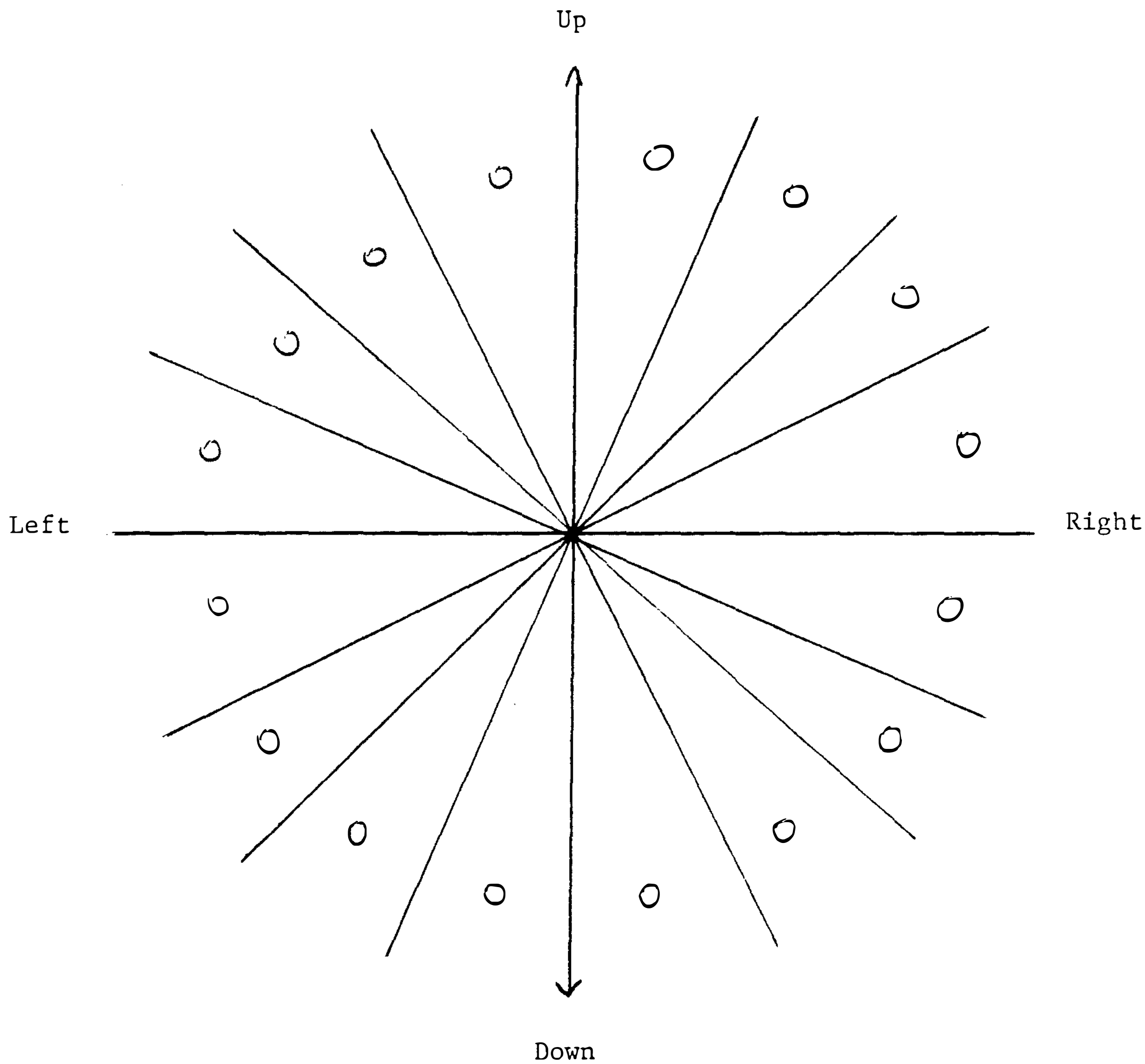
Figure 2

The Realignment of the 1850s



Source: Sundquist (1973, Figure 5-2)

Figure 3



0 - Legislators' most preferred, or "bliss" points

1 - Cleavages dividing legislators into two equal sized groups

Figure 4

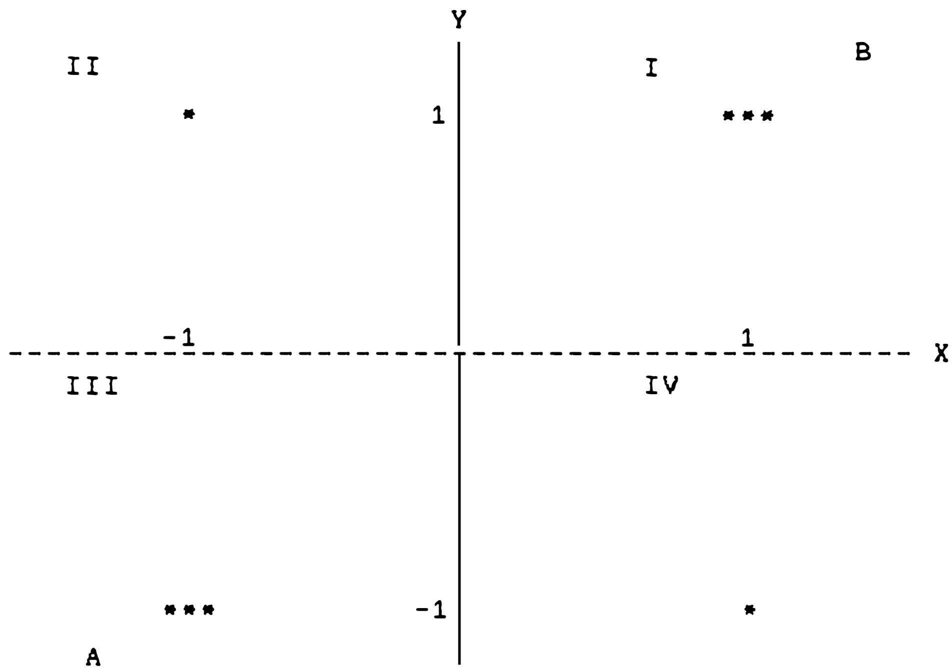


Figure 5

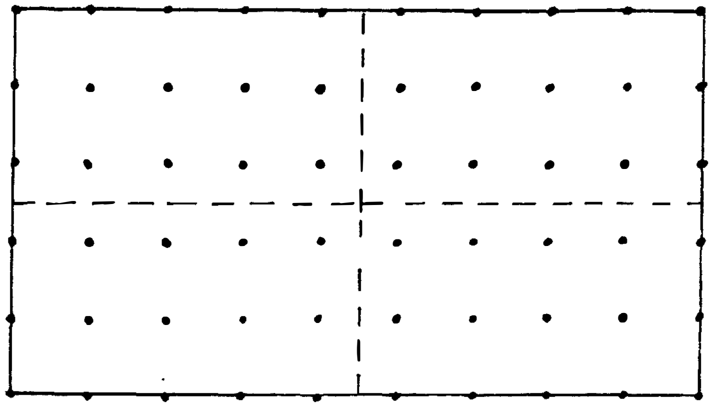


Figure 6

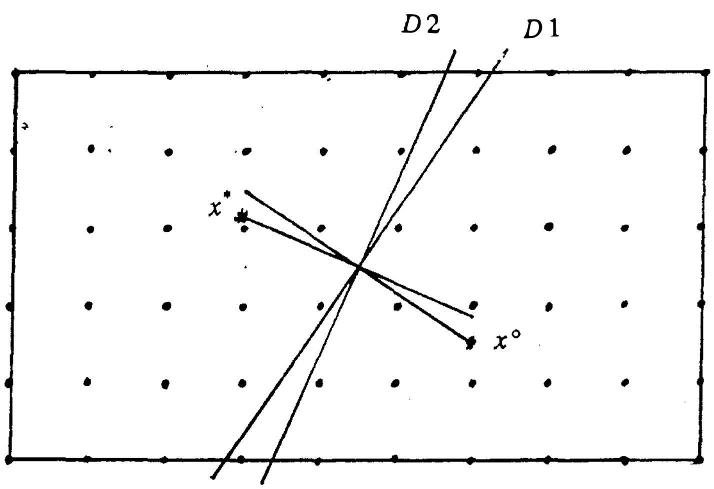


Table 2

Recalibrated Dimensional Findings

Study	Classification Success Reported	Recalibrated	
Poole-Rosenthal 1985b	One dimension	75% base	66.7% base
All roll calls			
Senate	81.632	26.5%	44.8%
House	84.033	36.1	52.1
< 60% majority			
Senate	83.856	35.4	51.5
House	82.498	30.0	47.4
Ladha 1984			
1977 Senate roll calls			
Linear model	80.7	22.8	42.0
Non-linear	81.7	26.8	45.0
Poole-Rosenthal	82.3	29.2	46.8
Categories:			
Budget general interest	79.79	19.2	39.3
Budget special interest	79.57	18.3	38.6
Regulation:			
General interest	85.99	44.0	57.9
Special interest	80.73	22.9	42.1
Domestic social policy	80.02	20.1	40.0
Defense & foreign policy:			
Budget	76.23	4.9	28.6
Resolutions	83.54	34.2	50.6
Government organization	80.05	20.2	40.1
Internal organization of Congress	78.71	14.8	36.1
10 Strip-Mining roll calls			
Non-linear model	78.15	12.6	34.4
	Regression Estimate		
Non-linear model	77.46	9.8	32.3

Table 3

Recalibrated Dimensional Findings:
Poole and Daniels 1985

Proportion of Roll-Call Votes Successfully Classified

	Reported		Recalibrated 75% base			Recalibrated 66.7% base		
	Number of Dimensions							
	One	Two	One	Two	Δ1-2	One	Two	Δ1-2
House:								
all votes	86.9	88.4	47.6	53.6	6.0	60.7	65.2	4.5
> 5% minority	83.6	85.2	34.4	40.8	6.4	50.8	55.6	4.8
> 20% minority	80.8	83.3	23.2	33.2	10.0	42.3	49.8	7.5
> 40% minority	80.8	83.3	23.2	33.2	10.0	42.3	49.8	7.5
Senate:								
all votes	85.4	87.7	41.6	50.8	9.2	56.2	63.1	6.9
> 5% minority	83.3	85.7	33.2	42.8	9.6	49.8	57.1	7.3
> 20% minority	81.5	84.2	26.0	36.8	10.8	44.4	52.6	8.2
> 40% minority	80.9	83.6	23.6	34.4	10.8	42.6	50.8	8.2

R^2 of Regression Results

	Reported			Recalibrated .5 base		
	Number of Dimensions					
	One	Two	Three	One	Two	Three
All votes	.812	.873	.887	.624	.746	.774
		Δ1-2	Δ2-3		Δ1-2	Δ2-3
		.061	.014		.122	.028

Note: Δi-j shows the classification success of the jth dimension.

Source: Poole and Daniels 1985, Tables 6 and 6A, Section 3.

Appendix A

For each number of dimensions n, there are 2^n legislators--one at each vertex of the n-dimensional hypercube. The legislators are represented by vectors; the 3 dimensional case is

Legislator				Left-Right	2's bill	Correct?
1	0	0	0	L	L	+
2	1	0	0	L	L	+
3	0	1	0	L	R	-
4	1	1	0	R	L	+
5	0	0	1	L	R	-
6	1	0	1	R	L	-
7	0	1	1	R	R	+
8	1	1	1	R	R	+

Arbitrarily, legislators 1 and 8 are the extreme left and right, implying the one-dimensional classification shown. A bill is then proposed for each of the 8 legislators, and the percent classified "correctly" (consistent with the L-R classification) is calculated. For example, legislator 2's proposal (or 7's equivalent bill), classifies 50% of the legislators correctly.

Because of the hypercube's symmetry, all points i = 0,..,n vertices from the left vertex have the same success ratio. The number of points i vertices from the left is given by the binomial distribution. There must be a principle behind correct classification, but while correct classification falls from 100% at the L-R extremes to 50% in the center, no general rule was found. The calculations of correct classification for n = 2-7 are shown, for i=0,1..n, and the total (average):

# of dimensions	# of points	% correct	Total (average) % correct
2:	1	1.0	
	2	.5	
	1	1.0	.75
3:	1	1.0	
	3	.5	
	3	.5	
	1	1.0	.625
4:	1	1.0	
	4	.625	
	6	.5	
	4	.625	
	1	1.0	.625
5:	1	1.0	
	5	.625	
	10	.625	
	10	.625	
	5	.625	
	1	1.0	.6484375

# of dimensions	# of points	% correct	Average
6:	1	1.0	
	6	.6875	
	15	.59375	
	20	.5	
	15	.59375	
	6	.6875	
	1	1.0	.5947266
7:	1	1.0	
	7	.6875	
	21	.6875	
	35	.5	
	35	.5	
	21	.6875	
	7	.6875	
	1	1.0	.5882031

The calculations by dimension weight each dimension equally.

Appendix B

The amount of correlation that is likely depends upon the number of data points and the number of dimensions. A very large amount of data should be nearly orthogonal, while smaller amounts of data should have increased correlations. As correlation follows the F distribution, it would be possible to work out the distribution of correlation for two dimensions.

Correlation increases the success ratio from 75% in two dimensions, approximately as the square of the correlation. For parallelograms with equal heights and lengths, the following were obtained:

Correlation	Success Ratio	Percent Increase over 75%	Corrected Average Success
0	.75	0%	31.328
.124	.765625	6.25	26.750
.243	.78125	12.5	21.518
.447	.8125	25	8.437
.707	.875	50	-

Thus, for moderate correlations, the corrected success ratios increase only moderately. However, they reduce the first dimension's power considerably; the last column shows the average success ratio of 82.832% corrected for various degrees of correlation.

Endnotes

*Comments from Howard Rosenthal, Keith Krehbiel, Jeffrey Miller, Jerrold Schneider, Jack Wright and members of the USC/UCLA Microeconomics Workshop were very helpful. They are not implicated in any of the conclusions.

1. However, Clausen and colleagues and Collie and Brady (1985) have found several independent dimensions. In her literature review, Collie (1985) regards this view as dominant.

2. However, lobbying and Presidential position have been examined. See E.g., Kau, Keenan and Rubin 1982. Jackson (1974) analyzes structure, but unfortunately was not imitated.

3. The literature on "spanning" suggests that the number of dimensions might be reduced considerably, but it seems to suggest that the number of financial dimensions alone would be in the hundreds or thousands.

4. See Coombs (1964), Poole (1984) and Poole and Rosenthal (1985a, 1985b).

5. Or, as with LISREL, dimensional scores can be used to define new variables.

6. Coombs' (1964, p. 21) relations between pairs of dyads, category Ia.

7. Collie (1985) reviews additional work. William Schneider (1982, 1983, 1984) applies the multidimensional approach to recent Congresses.

8. Correct categorization, rather than minimizing error (distance), is the success criterion used here, following most of the dimensional voting studies. It is reasonable for inherently 0-1 variables.

9. An analytically proved null hypothesis for scaling and unfolding has not been developed in the psychological literature. Instead, arbitrary success criteria (.9 in Guttman scaling) have been adopted (Torgerson 1958, Ch. 12.4).

10. An alternative, and in principle superior, approach is to compare the success of alternative theoretically based models. However, as yet these have not been developed.

11. Nonexperimental data ordinarily are correlated, but no "average" correlation is available; instead, techniques estimate the degree of correlation (multicollinearity) for particular data sets (Judge et. al., Chs. 4 & 22, 1985).

12. Bliss points should be derived from an underlying structure of tastes and constraints (Koford 1985).

13. The legislators' ADA ratings could measure "right" and "left".

14. The 6 votes in quadrants I and III are correctly classified. The 2 votes in quadrants II and IV are on the boundary Y = -X, and can be taken as half correct.

15. Thus, civil rights roll-calls were very important in the early 1960s, but not in the 1950s (Poole and Rosenthal 1985)

16. Weisberg (1978) also notes the 50% criterion, as well as the 2 and 3 party models, as null hypotheses.

17. Thus, there are equal numbers of extreme and moderate bills, while the previous case has, for larger n, mostly moderate and centrist bills. See Appendix A.

18. Assign each quadrant x,y values, e.g., A = -1,1; B = 1,1; C = -1,-1, D = 1,-1. The A-D dimension then has values x-y: A = -2, B = 0, C = 0, D = 2. Var x = 4, Var A-D = 8, Cova x/A-D = 4, so Corr = .7071.

19. The expected number of points < 75% is ~ 2 for the reported means and variances, so the absence of such points is not too unlikely.

20. Jerrold Schneider notes that legislators vote in such hectic conditions that many votes may be just plain mistakes. See also Matthews and Stimson (1975).

21. It might be useful to calculate success ratios for the British Parliament as a comparison.

22. The 50% criterion requires an infinite number of issues, all of insignificant importance. Perhaps a better null hypothesis would have an infinite number of issues that vary in importance, such as by the golden section.

23. Since dimensions are invariably correlated, this overstates the relative success of the first and second dimensions.

24. Compare Koford (1987).

25. Excellent examples are Kalt and Zupan (1984, forthcoming), Kau and Rubin (1979), Kau, Keenan and Rubin (1982), Peltzman (1984, 1985).

26. Ladha does not include ideology explicitly, but rather compares the success of a pure constituency and a unidimensional model. Nevertheless, his individual effects variable (XHAT) partly controls for ideology.

27. The only study to conclude that ideology is unimportant, Coughlin (1985), actually finds strong collinearity. The evidence that ideology does not make an independent contribution

is unfortunately based on the proportion of votes correctly classified, which rises from 81% to 82% when ideology is included. But the log of the likelihood ratio rises substantially, so ideology may be playing a significant independent role.

28. Koford (1987) provides a theory and some evidence for two similar-sized legislative parties.

29. This assumption is reasonable in this limited context, where intensity of preference does not count (and would not matter because of the symmetry assumptions; see Morrison 1972, Hinich 1977). It is not fully realistic, particularly for pork-barrel bills.

30. Matthews and Stimson (1975) describe the information and transactions costs of "ordinary" bills. The costs of organizing and passing "major" bills, and the problems when members find the party position far from their own, are described in Sinclair (1983).

31. The analogy is to Clower and Leijonhufvud's (1975) trading posts.

32. Compact, convex spaces with legislators evenly distributed in them, or comparable spaces with legislators largely close to the center have cleavages on all dimensions that divide the legislators equally. It is not known how broad the distribution of spaces with approximate generalized medians may be. The Plott-McKelvey literature showed that exact generalized medians in all directions are unlikely in the absence of symmetry. However, approximate generalized medians are more common (Tullock 1967). Transactions costs create a "band" around a center where the equilibrium still holds. Thus, there might be a level of transactions costs that would assure that the generalized median held. And this paper requires only the existence of a generalized median along the minimum-transaction-cost axis.

33. This is like the Parliamentary vote to decide the ruling party.

34. If there were many roll-call votes, but the voting pattern were exactly the same on each, the many votes would serve no purpose.

35. A one dimensional restriction on bills has often been included in models (Slutsky 1977, Enelow 1984, Shepsle 1979) to impose stability, which is imposed here by parties and transactions costs.

36. This helps explain the many votes where one side is a small minority.

37. Legislators may learn about their own preferences from considering votes on bills as well.

38. There is a close analogy tothe economics of tied goods or block booking (Kenney and Klein 1983).

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